

Plant and Equipment Expenditures by Business for Pollution Abatement, 1981 and Planned 1982

NONFARM business spent \$8.9 billion in 1981 for new plant and equipment to abate air and water pollution and to dispose of solid waste, down from \$9.2 billion in 1980, according to a survey conducted by BEA in late November and December 1981 (table 1). The 3-percent decrease in spending in 1981 was the first since the series began in 1973 (chart 3). Plans indicate spending will be \$9.4 billion in 1982.¹

These estimates are not adjusted for price change. Prices, as measured by the implicit price deflator for pollution abatement (PA) plant and equipment, increased 10 percent in 1981—the same increase as in 1979 and 1980 (table 2.)² Real spending for

PA plant and equipment decreased 12 percent in 1981, compared with a 1-percent decrease in 1980. Real spending for air PA, water PA, and solid waste disposal decreased 11 percent, 16 percent, and 2 percent, respectively.

Price information for the first quarter of 1982 suggests that prices are likely to increase less in 1982 than in 1981. In combination with the 5-percent planned increase in current-dollar spending, a reasonable range for price increase yields a 1- to 4-percent decrease in real PA plant and equipment spending—the third consecutive annual decrease. Plans for 1982 imply a continued decrease in real spending for air, more than offsetting increases for water and solid waste.

The first section of this article presents current-dollar spending patterns, focusing on actual spending in 1981 and planned spending for 1982. The second discusses the extent to which spending plans reported for 1974-81 have been realized.

Spending patterns

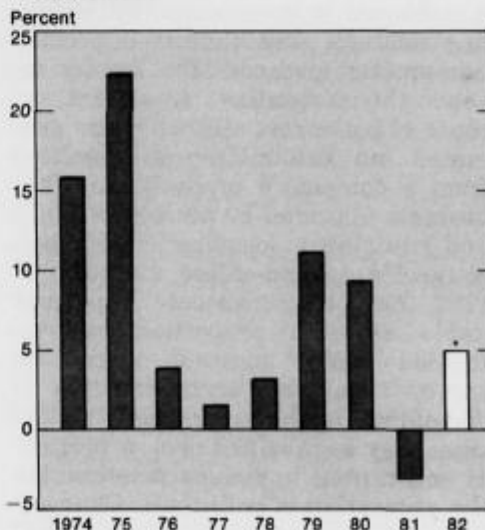
Of the \$8.9 billion spent for PA plant and equipment in 1981, \$5.0 billion was for air pollution abatement. This level of spending for air PA represents a decrease of 2 percent, following a 13-percent increase in 1980. Business plans another decrease in air PA spending of 1 percent in 1982. The Clean Air Act as amended in 1977 set a major deadline late this year for meeting Federal standards for air quality improvement. However, Congress is currently reexamining this Act; proposed amendments include provisions for postponement of the 1982 deadline.

NOTE.—William J. Russo, Jr., contributed significantly to this article, especially to the analysis of planned spending.

Spending for water PA plant and equipment decreased 7 percent (to \$3.0 billion) in 1981, following a 2-percent increase in 1980. Business plans a 13-percent increase in 1982—the largest increase since 1976. The next major deadline for meeting Federal standards for water pollution abatement is in 1984 and is for selected categories of pollutants. The Environmental Protection Agency (EPA) has recommended that provisions that postpone this deadline be enacted. Congress is likely to examine this EPA recommendation soon in preparing to reauthorize sections of the Clean Water Act.

Business increased spending for solid waste disposal plant and equipment 8 percent (to \$0.9 billion) in 1981—a much smaller increase than in 1979 (27 percent) and 1980 (20 percent). A 12-percent increase is planned in 1982. EPA is issuing haz-

CHART 3
Percent Change in New Plant and Equipment Expenditures for Pollution Abatement



*Planned
U.S. Department of Commerce, Bureau of Economic Analysis

1. Pollution abatement (PA) is the reduction or elimination of emissions of pollutants that is brought about by human activity directed to that purpose. Disposal of solid waste refers to the collection and disposal of solid waste by means acceptable to Federal, State, and local authorities. Part of expenditures for disposal of solid waste is not for PA, but presenting only the PA portion is not feasible at the level of detail in this article. For further discussion of pollution abatement and solid waste disposal, see John E. Cremeans, "Conceptual and Statistical Issues in Developing Environmental Measures—Recent U.S. Experience," *Review of Income and Wealth*, ser. 23 (June 1977): 97-115, and Gary L. Rutledge and Susan L. Trevathan, "Pollution Abatement and Control Expenditures, 1972-79," *SURVEY OF CURRENT BUSINESS* 61 (March 1981): 19-27.

The survey results are universe estimates for U.S. nonfarm business of PA plant and equipment expenditures, excluding expenditures for emission abatement devices on cars and trucks. The estimates are based on sample data from companies, each of which is assigned to a single industry corresponding to the industry classification of the company's principal product. For a brief description of survey methodology, see Technical Note 1 in Gary L. Rutledge and Betsy D. O'Connor, "Plant and Equipment Expenditures by Business for Pollution Abatement, 1973-80, and Planned 1981," *SURVEY* 61 (June 1981): 19-25, 30, and 72.

Expenditures by business for emission abatement devices on cars and trucks were \$2.0 billion in 1980. For earlier estimates of these expenditures, see Gary L. Rutledge and Susan L. Trevathan, "Pollution Abatement and Control Expenditures, 1972-80," *SURVEY* 62 (February 1982): 50-57.

2. Price indexes generally applicable to (although not specific to) PA plant and equipment are used to derive the price deflator for PA. Changes in the PA deflator primarily have reflected price changes; shifts in composition of purchases have affected the deflator only to a limited extent.

Table 1.—New Plant and Equipment Expenditures by U.S. Nonfarm Business: Total and for Pollution Abatement

(Billions of dollars)

	1980					1981					Planned 1982				
	Total ¹	Pollution abatement				Total ¹	Pollution abatement				Total ¹	Pollution abatement			
		Total	Air	Water	Solid waste		Total	Air	Water	Solid waste		Total	Air	Water	Solid waste
Total nonfarm business	266.43	9.30	6.87	3.28	0.85	321.49	8.93	4.97	3.04	0.92	345.11	9.27	4.91	2.43	1.03
Manufacturing	135.81	5.52	2.88	2.09	.55	196.79	5.32	2.69	2.10	.53	136.81	5.78	2.67	2.44	.57
Durable goods	86.91	2.27	1.42	.69	.16	61.84	1.97	1.09	.70	.18	67.24	2.19	1.14	.82	.23
Primary metals ²	1.71	.98	.67	.26	.04	3.12	.78	.54	.19	.08	3.74	.86	.64	.34	.01
Blas furnaces, steel works	3.29	.61	.41	.19	.01	8.17	.53	.38	.18	.02	4.07	.51	.39	.18	.03
Nonferrous metals	3.11	.27	.17	.07	.03	3.44	.23	.16	.05	.03	2.95	.26	.17	.06	.03
Fabricated metals	2.98	.07	.02	.03	.01	2.94	.07	.02	.04	(*)	3.23	.07	.02	.04	.01
Electrical machinery	9.69	.19	.07	.06	.02	10.81	.16	.06	.07	.02	12.68	.24	.11	.10	.03
Machinery, except electrical	11.98	.16	.07	.07	.01	13.22	.16	.06	.09	.01	14.91	.18	.06	.10	.01
Transportation equipment ³	18.16	.42	.31	.17	.04	18.89	.46	.20	.21	.08	18.69	.49	.19	.23	.07
Motor vehicles	9.06	.39	.26	.13	.02	10.08	.35	.16	.16	.04	9.49	.38	.16	.18	.04
Aircraft	7.03	.10	.04	.04	.02	8.43	.10	.03	.05	.02	7.25	.10	.03	.06	.03
Stone, clay, and glass	3.32	.26	.21	.03	.01	3.14	.16	.12	.03	.01	3.18	.17	.12	.03	.03
Other durables ⁴	5.09	.14	.07	.06	.01	5.63	.16	.07	.09	.02	5.29	.19	.10	.07	.03
Non-durable goods	56.90	3.25	1.46	1.40	.40	64.96	3.44	1.69	1.39	.45	68.58	3.69	1.63	1.63	.44
Food including beverages	1.33	.27	.08	.18	.02	8.23	.30	.13	.14	.04	8.07	.27	.12	.13	.02
Textiles	1.62	.07	.05	.02	(*)	1.54	.05	.03	.02	(*)	1.52	.05	.02	.03	(*)
Paper	8.50	.39	.16	.16	.07	8.72	.38	.16	.12	.11	8.76	.46	.26	.17	.06
Chemicals	12.59	.78	.33	.32	.10	13.69	.88	.38	.36	.14	15.82	.97	.43	.43	.15
Petroleum	20.49	1.71	.88	.53	.13	25.86	1.79	.88	.74	.14	28.99	1.72	.71	.83	.19
Rubber	1.73	.03	.02	.01	.01	1.77	.04	.02	.02	.01	2.03	.06	.02	.02	.01
Other non-durables ⁴	8.98	.04	.01	.02	.01	6.69	.04	.02	.01	.01	5.87	.04	.02	.01	.01
Nonmanufacturing	179.51	3.89	2.19	1.29	.54	194.70	3.61	2.28	.84	.29	268.30	3.49	2.24	.99	.35
Mining	13.51	.48	.17	.22	.10	14.98	.46	.18	.18	.10	15.33	.61	.23	.24	.14
Transportation	12.43	.11	.09	.06	.01	12.95	.09	.04	.04	.01	13.33	.13	.06	.06	.01
Railroad	4.55	.04	.01	.03	(*)	4.24	.04	.02	.02	(*)	4.55	.06	.03	.03	(*)
Air	4.91	.01	(*)	(*)	(*)	3.81	.01	(*)	(*)	(*)	4.15	.02	.01	.01	(*)
Other	3.52	.01	.03	.03	.01	4.90	.02	.02	.02	(*)	4.98	.06	.02	.03	(*)
Public utilities	35.44	2.88	1.65	.89	.15	38.40	2.80	1.59	.87	.15	40.80	2.71	1.59	.86	.15
Electric	28.12	2.52	1.32	.86	.14	29.74	2.71	1.51	.85	.15	31.77	2.63	1.52	.83	.15
Gas and other	7.32	.36	.33	.03	.01	8.66	.09	.08	.02	(*)	9.03	.07	.06	.02	(*)
Trade and services	81.79	.37	.03	.04	(*)	85.33	.11	.06	.04	.03	89.46	.16	.06	.03	.03
Communication and other ⁵	35.98	.04	.03	.01	(*)	41.86	.03	.02	.01	(*)	45.75	.04	.03	.01	.01

* Less than \$5 million.

1. Consists of final estimates taken from the quarterly survey of total new plant and equipment and, for 1982, plans based on the 1981 fourth-quarter Survey taken in late January and February 1982.

2. Includes industries not shown separately.

3. Consists of lumber, furniture, instruments, and miscellaneous.

4. Consists of apparel, tobacco, leather, and printing/publishing.

5. Consists of communication; construction; social services and membership organizations; and forestry, fisheries, and agricultural services.

ardous waste regulations implementing a major section of the Resource Conservation and Recovery Act and plans to have them all in effect this year.

Air and water pollution abatement is achieved in two ways—by end-of-line methods and changes-in-production-process methods. The former involve the separation, treatment, or reuse of pollutants after they are generated but before they are emitted from a company's property. In 1981, business allocated 80 percent of plant and equipment spending for air and water PA to end-of-line methods; in 1982, they plan to allocate 79 percent (table 3). This proportion has remained fairly constant since the survey began. As an alternative to end-of-line methods, production processes may be modified or new processes substituted to reduce or eliminate the generation of pollutants. Changes-in-production-process methods entail spending for both PA and other purposes, such as the reduction of pro-

duction costs, but survey respondents are asked to report only the part of spending that is for pollution abatement. Table 4 shows changes-in-production-process spending by major industry groups.

In 1981, business allocated 2.8 percent of total plant and equipment spending to PA—down from 3.1 per-

cent in 1979 and 1980. Plans indicate a decrease to 2.7 percent in 1982. If business spending for motor vehicle emission abatement devices is added to PA plant and equipment spending reported from the survey, the allocation in 1980 would be 3.8 percent and (based on preliminary data) 3.7 percent in 1981.

Table 2.—New Plant and Equipment Expenditures for Pollution Abatement in Current and Constant Dollars With Implicit Price Deflators

	1973	1974	1975	1976	1977	1978	1979	1980	1981
Billions of dollars									
Total	4.92	5.79	6.97	7.23	7.39	7.58	7.42	8.20	8.83
Air	2.95	3.37	4.02	3.81	3.80	3.91	4.50	5.07	4.97
Water	1.99	1.98	2.66	2.97	3.04	3.11	3.21	3.29	3.94
Solid waste	.91	.40	.39	.46	.55	.56	.71	.86	.92
Billions of constant (1972) dollars									
Total	4.87	4.68	5.16	5.09	4.83	4.94	4.69	4.64	4.88
Air	2.79	2.74	2.98	2.84	2.46	2.38	2.20	2.54	2.25
Water	1.68	1.60	1.95	2.14	2.06	1.93	1.81	1.70	1.43
Solid waste	.39	.34	.23	.32	.35	.38	.28	.41	.40
Implicit price deflators, 1972=100									
Total	105.5	121.8	135.4	142.9	151.8	162.2	179.6	196.1	218.6
Air	105.0	122.6	137.4	144.5	154.5	164.5	182.2	199.6	220.6
Water	105.5	121.0	131.4	139.9	148.4	161.1	171.2	183.4	212.9
Solid waste	104.8	119.8	134.4	141.6	152.9	168.0	186.2	206.7	228.4

1. The implicit price deflators for 1981 are based on preliminary source data.

Table 3.—New Plant and Equipment Expenditures by U.S. Nonfarm Business for Air and Water Pollution Abatement by End-of-Line Methods¹

(Billions of dollars)

	1980			1981			Planned 1982		
	Total	Air	Water	Total	Air	Water	Total	Air	Water
Total nonfarm business.....	4.84	4.18	2.92	6.40	4.83	2.37	6.58	3.91	2.67
Manufacturing.....	4.02	2.37	1.71	3.35	2.17	1.68	3.98	2.08	1.50
Durable goods.....	1.85	1.10	.63	1.35	.83	.51	1.17	.86	.50
Primary metals.....	.81	.47	.24	.62	.46	.18	.65	.45	.31
Iron and steel.....	.54	.28	.18	.44	.31	.13	.45	.28	.17
Nonferrous metals.....	.18	.14	.06	.14	.11	.03	.16	.12	.04
Fabricated metals.....	.04	.02	.03	.04	.01	.03	.04	.02	.03
Electrical machinery.....	.09	.05	.04	.04	.02	.04	.15	.08	.07
Machinery, except electrical.....	.11	.05	.06	.11	.03	.08	.13	.04	.09
Transportation equipment ².....	.01	.19	.12	.23	.11	.12	.35	.13	.14
Motor vehicles.....	.25	.16	.09	.18	.09	.09	.19	.08	.11
Aircraft.....	.05	.03	.02	.05	.02	.03	.06	.02	.03
Stone, clay, and glass.....	.10	.16	.08	.12	.18	.02	.12	.10	.02
Other durables ³.....	.10	.06	.05	.11	.05	.05	.12	.07	.05
Nondurable goods.....	2.27	1.21	1.16	2.50	1.34	1.17	2.82	1.32	1.38
Food including beverage.....	.17	.04	.18	.18	.09	.03	.16	.08	.06
Textiles.....	.02	.01	.02	.02	.01	.02	.04	.01	.03
Paper.....	.26	.12	.14	.15	.09	.07	.22	.14	.08
Chemicals.....	.54	.27	.27	.68	.35	.33	.75	.36	.39
Petroleum.....	1.12	.74	.38	1.40	.77	.63	1.29	.89	.69
Rubber.....	.02	.01	.01	.03	.01	.02	.04	.02	.02
Other nondurables ⁴.....	.60	.31	.22	.03	.02	.01	.03	.02	.01
Nonmanufacturing.....	0.75	1.06	.91	2.05	1.86	.89	2.50	1.82	.77
Mining.....	.34	.16	.20	.34	.17	.17	.44	.21	.23
Transportation.....	.03	.03	.04	.07	.04	.03	.09	.05	.06
Railroad.....	.03	.01	.03	.03	.01	.02	.06	.02	.02
Air.....	(*)	(*)	(*)	(*)	(*)	(*)	(*)	(*)	(*)
Other.....	.04	.02	.02	.04	.02	.03	.04	.03	.02
Public utilities.....	2.25	1.61	.64	2.06	1.61	.46	1.88	1.61	.47
Electric.....	2.22	1.58	.60	2.01	1.58	.44	1.86	1.50	.46
Gas and other.....	.03	.03	.04	.05	.03	.02	.02	.03	.01
Trade and services.....	.05	.05	.06	.05	.05	.05	.05	.05	.02
Communication and other ⁵.....	.03	.02	.01	.02	.02	(*)	.03	.02	(*)

* Less than \$5 million.

1. End-of-line methods involved the separation, treatment, or reuse of pollutants after they are generated but before they are emitted from a company's property. Changes-in-production-process estimates for air and water pollution abatement can be derived by subtracting estimates in this table from those in table 1.

2. Includes industries not shown separately.

3. Consists of lumber, furniture, instruments, and miscellaneous.

4. Consists of apparel, tobacco, leather, and printing-publishing.

5. Consists of communication; construction; social services and membership organizations; and forestry, fisheries, and agricultural services.

Industry detail.—Manufacturing industries decreased current-dollar spending for PA plant and equipment 2 percent in 1981; nonmanufacturing industries decreased spending 5 percent. Every major industry group except nondurables manufacturing decreased spending (table 5). Of the largest spenders (those spending \$200 million or more for PA plant and equipment), the only increases were by chemicals, 21 percent; food and beverage, 11 percent; and petroleum, 3 percent. Of the remaining large

spenders, the largest decreases were by iron and steel, 20 percent; nonferrous metals, 15 percent; and motor vehicles, 10 percent.

In 1982, manufacturing industries plan a 7-percent increase in spending and nonmanufacturing industries plan a 2-percent increase. Most industries plan increases. Of the large spenders, the largest planned increases are by electrical machinery and mining, 83 percent each; paper, 26 percent; nonferrous metals, 13 percent; and chemicals, 10 percent. The two industries that spend the most for PA plant and equipment—electric utilities and petroleum—plan decreases of 3 percent and 2 percent, respectively.

Industries that allocated the largest proportions of total plant and equipment spending to PA in 1981 were iron and steel, 15 percent; electric utilities, 9 percent; nonferrous metals and petroleum, 7 percent each; and chemicals and paper, 6 percent each. As shown in chart 4, these allocations decreased from 1980 to 1981 for all

except chemicals. Plans for 1982 indicate decreased allocations for iron and steel, electric utilities, chemicals, and petroleum; increased allocations are planned for nonferrous metals and paper. Over the 1973-81 period, allocations for petroleum, paper, and chemicals have shown a downtrend since the mid-seventies. Allocations peaked in 1973 for nonferrous metals and in 1979 for iron and steel. Allocations for electric utilities have remained relatively flat.

Table 5.—New Plant and Equipment Expenditures for Pollution Abatement: Percent Change From Preceding Year

	1980	1981	Planned 1982
Total nonfarm business.....	9.3	-2.9	4.9
Manufacturing.....	14.5	-1.8	6.6
Durable goods.....	12.5	-13.3	11.2
Nondurable goods.....	18.2	6.5	3.8
Nonmanufacturing.....	2.5	-4.9	2.3
Mining.....	-8.9	-4.2	32.6
Transportation.....	10.0	-18.2	44.4
Public utilities.....	4.7	-2.6	-3.7
Trade and services.....	-18.8	-35.3	-9.1
Communication and other.....	-25.0	-	33.3

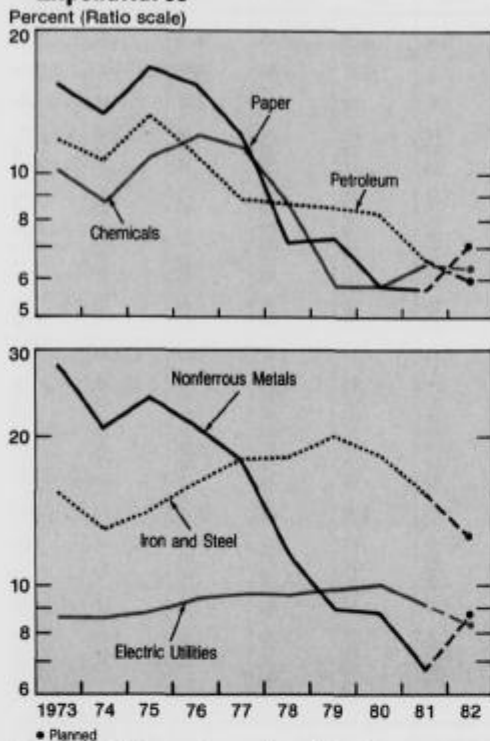
Table 4.—New Plant and Equipment Expenditures for Air and Water Pollution Abatement by Changes-in-Production-Process Methods

(Billions of dollars)

	1980	1981	Planned 1982
Total nonfarm business.....	1.55	1.41	1.37
Manufacturing.....	.34	.34	1.18
Durable goods.....	.46	.44	.49
Nondurable goods.....	.48	.51	.64
Nonmanufacturing.....	.61	.67	.84
Electric utilities.....	.46	.55	.50
Other nonmanufacturing.....	.15	.12	.14

CHART 4

Pollution Abatement as a Percentage of Total New Plant and Equipment Expenditures



U.S. Department of Commerce, Bureau of Economic Analysis

The realization of plans

Although the PA plant and equipment series is short, tentative evaluation of the extent to which spending plans are realized is possible. In this section, simple correlation analysis is used to compare spending plans with actual spending. Patterns are then noted and possible causes are discussed. The effect of systematic bias on the accuracy of reported spending plans is evaluated next, followed by a comparison of reported plans and projections based on mechanical methods.

The first year for which planned spending for PA plant and equipment is available is 1974 and the last year for which actual spending is available is 1981, so that the period for comparison of planned to actual spending consists of 8 years, 1974-81. Trends in planned and actual spending are similar (chart 5). The simple correlation coefficient for the two series is 0.90. The similarity is notably smaller if changes in levels, instead of levels, are compared. The simple correlation coefficient for these changes is 0.58.

Annual patterns.—Actual spending for PA plant and equipment fell short of planned spending in 6 of the 8 years. A similar pattern is evident for major industry groups: Actual spending fell short of that planned by durable goods industries in 7 years, by nondurables in 4 years, and by nonmanufacturing in 6 years (table 6).

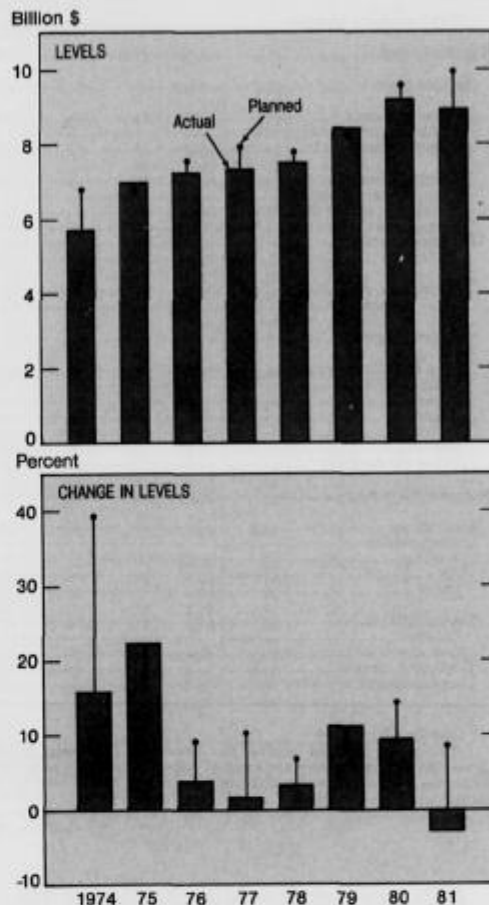
In contrast, for total plant and equipment, actual spending exceeded that planned in 5 of the 8 years. Actual spending exceeded that planned by durable goods industries in 5 years, by nondurables in 6 years, and by nonmanufacturing in 4 years. Also, the percentage by which actual spending differed from planned spending (without regard to sign) was smaller in most years for total plant and equipment than for PA plant and equipment.

The tendency for actual spending to fall short of that planned for PA plant and equipment probably reflects characteristics of the PA regulatory process. Many rules were issued during 1974-81. They were often complicated, and they and associated compliance schedules were subject from time to time to refinement and reinterpretation. The certainty of vigorous enforcement varied among rules and for different deadlines. In this complex situation, businesses may have overplanned (i.e., planned PA capital spending projects that could be postponed or scaled down) as a way to safeguard against more stringent interpretation or more vigorous enforcement. Alternatively, businesses may have simply underestimated the complexity of the situation and encountered delays in following the details of rules and obtaining approvals of needed permits for PA projects.

Although characteristics of the PA regulatory process appear to be the most likely explanation of the tendency for actual spending to fall short of that planned, there are several other possibilities. First, the possibility that the observed tendency results from chance alone cannot be ruled out. Probability theory suggests that, if the chance of actual spending falling short of planned spending is equal to that of actual spending exceeding plans and if the formation of business plans each year is independent of the same process in other years, then the

CHART 5

Planned and Actual Pollution Abatement Plant and Equipment Expenditures



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likelihood of actual spending falling short of that planned six or more times out of eight is 14 percent. The possibility that refinement of statistical procedures might reduce the frequency with which actual spending falls short of that planned also cannot be ruled out. Improvement, if feasible, of planned spending totals using systematic bias adjustment procedures (such procedures are briefly discussed later) specific to PA might have this effect. Finally, business conditions other than characteristics of the PA regulatory process affect the realization of PA spending plans.

Systematic bias.—Systematic bias is that portion of the deviation of planned spending from actual spending assumed to be due to factors other than economic and operating conditions. Because the PA spending series is short, bias correction factors are not yet derivable from it for most years and factors from the total plant

and equipment spending estimates must be used to adjust PA spending. For example, if total plant and equipment spending for an industry is decreased 1 percent to remove systematic bias, then PA spending for that industry is also decreased 1 percent.

The bias adjustment procedure lowered the mean absolute percent deviation—the average of percent deviations without respect to sign—between planned and actual PA spending for 1974-81 from 10.7 percent to 7.8 percent, significantly improving the accuracy of reported plans as published. The improvement occurred in most years and across major industry groups. The breadth of improvement is evident from table 6, where percent deviations are observable by subtracting 100 from the figures shown.

Although the same sources of systematic bias in plans for total plant and equipment spending apparently affect plans for PA spending, it is unlikely that the effect is proportional, as is currently assumed when adjusting PA spending.⁵ An adjustment designed specifically for PA would eliminate the need for the proportionality assumption. For two of three years (1979-81) for which a PA-specific adjustment is available, it yields a smaller absolute percent error than the adjustment currently used.

Comparison with mechanical projections.—Errors in reported plans may be compared with errors that arise from mechanical methods of projecting spending. The simplest mechanical method is based on the no-change assumption—that is, the assumption that future spending will equal current spending. A second method is based on the same-change assumption—that is, the assumption that the percent change from the current level will equal the most recently observed percent change in actual spending. The root-mean-square error (RMSE) is used in evaluating these errors. It resembles an arithmetic mean of errors without respect to sign; the difference is that dispersion in the size of errors around their mean increases the RMSE but does not increase the arithmetic mean without respect to

Table 6.—New Plant and Equipment Expenditures for Pollution Abatement: Planned Expenditures as a Percentage of Actual Expenditures

	1974	1975	1976	1977	1978	1979	1980	1981	Mean absolute percent deviation, 1974-81 ^a
After systematic bias adjustment ¹									
Total nonfarm business	126.6	96.1	105.3	108.3	103.8	97.3	104.9	112.0	7.8
Manufacturing	123.8	91.3	100.6	110.8	105.3	100.1	108.2	117.0	8.8
Durable goods	125.4	90.7	105.5	116.9	113.3	102.2	119.6	128.1	12.7
Non-durable goods	122.5	86.0	97.3	107.1	100.0	96.6	100.3	111.9	7.4
Nonmanufacturing	114.8	107.7	114.8	105.8	101.9	95.3	99.7	104.3	0.9
Before systematic bias adjustment ¹									
Total nonfarm business	124.5	92.7	110.8	112.9	103.8	102.1	109.3	117.5	10.7
Manufacturing	121.4	97.5	106.8	118.8	112.5	106.7	115.3	122.9	14.6
Durable goods	123.9	107.3	113.4	124.6	120.9	106.1	124.3	130.5	20.3
Non-durable goods	120.6	91.4	104.8	115.2	107.2	105.7	106.8	118.6	12.1
Nonmanufacturing	111.6	105.0	115.8	105.4	103.5	95.9	102.8	107.7	6.7

¹Systematic bias is that portion of the deviation of planned spending from actual spending assumed to be due to factors other than economic and operating conditions. Planned spending, as published, is after bias adjustment.

^aThe mean absolute percent deviation can be derived in three steps: (1) subtract 100 from annual percentages shown, (2) take the absolute values, and (3) average these values for 1974-81.

Table 7.—Root-Mean-Square Errors (RMSE) in Annual Projections of Pollution Abatement Plant and Equipment Expenditures for 1975-81

	RMSE in annual projections for 1975-81				Ratio of RMSE's			
	Mechanical projections		Reported plans		Reported plans to no-change projections		Reported plans to same-change projections	
	No-change projections	Same-change projections	After systematic bias adjustment of plans ¹	Before systematic bias adjustment of plans ¹	After bias adjustment of plans	Before bias adjustment of plans	After bias adjustment of plans	Before bias adjustment of plans
Total nonfarm business	16.29	8.31	6.79	16.47	0.42	1.82	0.73	1.12
Manufacturing	18.77	15.70	8.52	13.95	.69	1.61	.61	.89
Durable goods	11.80	15.29	14.58	19.38	1.27	1.74	.85	1.28
Non-durable goods	7.65	18.08	0.34	11.43	.53	.65	.52	.63
Nonmanufacturing	11.94	8.06	3.30	7.79	.70	.65	1.03	.97

Note.—Formulas for RMSE's are as follows:

$$\sqrt{\frac{1}{n} \sum \left(\frac{A_t - A_{t-1}}{A_{t-1}} \right)^2}$$

$$\sqrt{\frac{1}{n} \sum \left(\left(\frac{A_t - A_{t-1}}{A_{t-1}} \right) - \left(\frac{A_{t-1} - A_{t-2}}{A_{t-2}} \right) \right)^2}$$

$$\sqrt{\frac{1}{n} \sum \left(\frac{A_t - A_{t-1}}{A_{t-1}} \right)^2}$$

where n is the number of observations; A_t , A_{t-1} , and A_{t-2} are PA plant and equipment spending in years t , $t-1$, and $t-2$; and A_{t-1} is planned PA plant and equipment spending for year t , as of year $t-1$.

¹Systematic bias is that portion of the deviation of planned spending from actual spending assumed to be due to factors other than economic and operating conditions. Planned spending, as published, is after bias adjustment.

sign.⁶ Comparison of the RMSE's are limited to 1975-81 because a projection of spending based on the same change assumption is not possible for 1974.

The RMSE's are compared in table 7 for major industry groups, before and after systematic bias adjustment of planned PA spending. After adjustment for systematic bias, reported

plans usually outperform both no-change and same-change projections of PA spending at the all industry level and for major industry groups. Before adjustment, both no-change and same-change projections outperform reported plans at the all industry level; this result primarily reflects the large RMSE in plans of durable goods industries.⁷

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5. For discussion of sources of systematic bias, see Genevieve B. Wimsatt and John T. Woodward, "Revised Estimates of New Plant and Equipment Expenditures in the United States, 1947-82: Part II," *Survey* 50 (February 1970): 19-39.

6. The root-mean-square error is calculated by (a) squaring the error for each observation, (b) adding all the squared errors, (c) dividing the sum of the squared errors by the number of observations to obtain the mean squared error, and (d) taking the square root of the mean squared error.

7. For information on mechanical projections of total plant and equipment spending, see Frank de Leeuw and Michael J. McKelvey, "The Realization of Plans Reported in the BEA Plant and Equipment Survey," *Survey* 61 (October 1981): 28-37.

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Summary.—A tentative evaluation of planned spending for PA plant and equipment compared with actual spending indicates that:

- (1) The correlation of planned and actual levels of spending is moderately strong; the correlation of planned and actual changes is less strong, although significant.

- (2) Actual spending often fell short of planned spending in 1974-81; the regularity of the shortfall probably reflects characteristics of the PA regulatory process.

- (3) The systematic bias adjustment procedure currently used is performing well; it reduces mean absolute percent deviation. A systematic bias adjustment procedure specifically designed for PA

might further reduce absolute percent deviation between planned and actual spending.

- (4) After adjustment for systematic bias, reported plans for 1975-81 usually outperform projections of spending based on two mechanical rules; this result appears to be attributable to the bias adjustment, especially for durable goods industries.

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creased 21 percent due to a 12-percent rise in average expenditures and an 8-percent rise in the number of travelers. This was the only overseas area in which there was an increase in the number of U.S. travelers.

Canada.—U.S. travel payments to Canada accounted for 18 percent of total U.S. travel expenditures, at \$2.0 billion, they were up 12 percent from 1980. Average expenditures increased 8 percent and the number of U.S. travelers increased 8 percent.

U.S. auto travelers to Canada returning the same day they entered accounted for 68 percent of travelers to Canada in both 1980 and 1981, up from 58 percent in 1977-79. Lower Canadian gasoline prices contributed to the 1980 increase. Canadian prices remained attractive to U.S. border area residents in 1981, although the gasoline price differential decreased toward the end of the year, as did same-day auto travel from the United States.

Travel to Canada over land (auto, bus, or train) accounted for 93 percent of all U.S. travel to Canada in 1981,

up from 85 percent in 1977-78. The attraction of lower Canadian gasoline prices and higher air fares were largely responsible for the change.

Mexico.—U.S. travel payments to Mexico increased 12 percent to \$2.9 billion, accounting for 25 percent of total U.S. travel expenditures. Expenditures in the Mexican border area increased 16 percent to \$1.6 billion, as lower Mexican gasoline prices drew U.S. border area residents to Mexico to purchase gasoline. Expenditures in Mexico's interior increased 8 percent to \$1.2 billion, following a decrease in 1980.